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The battle for technological supremacy: The US vs. China

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"You come at the king; you best not miss".
(If you attack the king, you better not miss).

Omar Little (*The Wire*)

Abstract:

Throughout history, technological superiority has been a decisive factor in the outcomes of conflicts and wars. From the invention of the bow and arrow to the advent of gunpowder and, more recently, nuclear weapons, those who have developed and mastered advanced technologies have consistently gained a clear upper hand on the battlefield. This technological supremacy has not only enabled armies to defeat their adversaries in direct confrontations but has also shaped military strategy and the ability of states to project power beyond their borders.

The Industrial Revolution marked a turning point, as the nations that industrialized rapidly could mass-produce weapons, vehicles, and other war tools, outpacing those that lagged in technological development. During World War II, for instance, the ability of the United States and its allies to innovate in areas such aviation, cryptography, and, ultimately, nuclear energy played a crucial role in defeating the Axis powers. Technological superiority translated not only into military victories but also into the consolidation of political and economic power on a global scale.

In our time, a fierce battle for supremacy runs in the realm of semiconductors, a critical component in virtually all aspects of modern technology. These tiny chips are the heart of the electronic devices that drive digital economies, from smartphones to data centres and advanced defence systems. The competition to dominate semiconductor production has escalated to new heights, with the United States, China, and other nations pouring billions of dollars into research and manufacturing, fully aware that leadership in this sector could determine economic and military dominance in the 21st century.

Keywords:

US, China, World order, Chips, Semiconductors, Technological competition, Digital sovereignty, Huawei, CHIPS Act, Restrictions, Sanctions, Export control.

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Introduction

The technology tug-of-war between the United States and the People's Republic of China has become a crucial battle of the 21st century. Both giants are fighting to dominate emerging technologies that will shape the future, seeking first-mover advantage in disruptive innovations and in leading the large-scale commercialisation of these technologies. This is reflected in our country's *National Security Strategy 2021.*[1]

For decades, the United States held undisputed supremacy in the creation and expansion of new technologies, while China lagged behind. However, the landscape has drastically changed. China has emerged as the leading contender to overtake US technological hegemony.

Under the Trump administration, economic relations between the two powers entered a new phase of hostility, marked by a policy centred on the adoption of tariffs and strict export controls. The Biden administration has largely continued these policies, intensifying measures to prevent China's access to critical technologies. In fact, the possibility of restricting US investment in China has become another tool in the containment strategy.

Washington faces three key strategic challenges: preserving its technological development and innovation advantage over China, aligning its strategy with that of its allies while garnering support of non-aligned nations, and maintaining international cooperation in trade and science.

State of play: from optimism to challenge

A scenario in which China may overtake the United States in the coming decade or so is not inevitable, but it cannot be ruled out either. In recent years both powers have intensified their race to dominate key technology areas, such as advanced semiconductors, artificial intelligence and quantum computing. The United States,

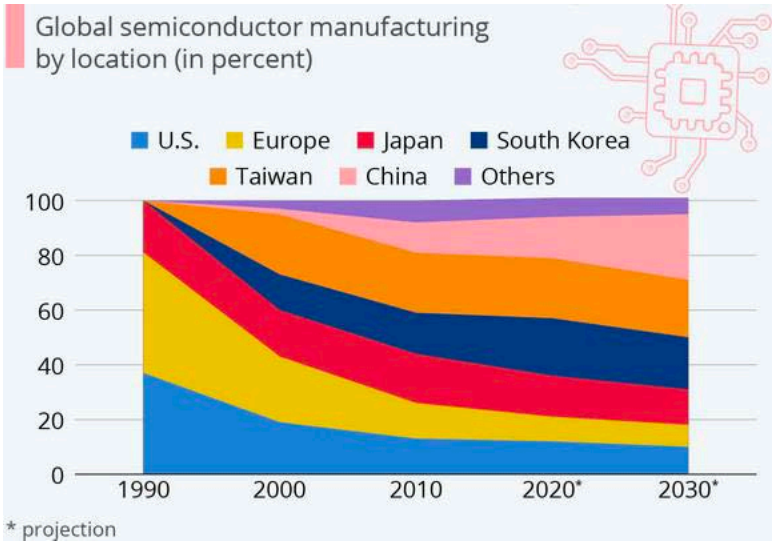
[1] ESN2021. Ch. 1. "The dispute is particularly intense in the technological sphere, where a race for global supremacy is taking place, including the control of exports of critical and dual-use technologies. China, which has made great strides in 5G technology and artificial intelligence, is seeking to achieve a position of pre-eminence that will allow it to define technical and industry standards and protocols, as well as to take the lead in foreign direct investment in network operators and services."
National Security Strategy 2021 - DSN
Note: All hyperlinks in this document have been verified as active as of 22 January 2025

hitherto the undisputed leader, now faces a formidable competitor in China, which has focused its efforts on achieving technological self-sufficiency and overtaking its rival.

The semiconductor sector encompasses the range of industrial activities involved in the design and manufacture of microprocessors and other essential electronic components that form the backbone of the technology products and services that underpin the modern digital economy. They are central to cross-cutting applications that include the energy sector, telecommunications and the data centres that underpin the internet and its myriad digital platforms.

In essence, semiconductors have become a staple of all technology sectors, giving them crucial geostrategic importance in a world increasingly dependent on digital transformation.

The recent global shortage of semiconductors, caused in part by disruptions in global supply chains in the wake of the pandemic, has highlighted Western dependence. This shortfall forced factory closures in a wide range of sectors, from automotive to medical devices. This underlined the vulnerability to a limited number of suppliers for essential sectors in a complex geopolitical environment.



Source: INE2022 annuary

Image1 . Where is % semiconductor production located?

The relationship between China and the US has evolved from cautious cooperation after the Cold War to today's open and strategic competition. In the 2000s, China's US-backed entry into the World Trade Organisation was seen as a step towards its integration into

the current rules-based global order. However, the past two decades have shown that this vision was naïve at best. China aspires to reshape the international order by giving itself the role it believes it deserves—using technology as a key instrument of revisionism.

In this arena of global competition, Chinese leader Xi Jinping has maintained that "technological innovation has become the main battleground"[2] . In 2015, Beijing launched its ambitious "Made in China 2025" plan[3] , a policy designed to transform China into an advanced technology powerhouse and reduce its dependence on foreign technology and imports. In parallel, China introduced the Digital Silk Road, a programme linking Chinese infrastructure investment with the adoption of Chinese technologies by host countries, as part of the *Silk Road Economic Belt* Initiative[4] . At the Belt and Road Forum[5] in Beijing in October 2023, Xi announced a new 'artificial intelligence governance' programme and reiterated his support for international cooperation in science and technology.

In some ways, it can be argued that the US is pursuing similar goals to China. Washington has set out to accelerate innovation and stay as far ahead of Beijing as possible in artificial intelligence and advanced semiconductor capabilities.

A legal offensive with loopholes

With the literal goal of "boosting innovation and domestic production" and the real objective of reducing the disproportionate global share of semiconductors (90%) currently manufactured in Taiwan given the high supply risk that could result from a conflict with China over the disputed island, Washington passed the CHIPS Act and Science[6] in 2022

[2] https://legrandcontinent.eu/es/2024/07/15/china-el-reajuste-de-xi-la-estrategia-del-tercer-pleno-en-10-puntos/

[3] "Made in China 2025 is an industrial plan that aims to transform China from a low-cost manufacturer to a world leader in high-tech manufacturing. This plan focuses on ten key sectors, such as information technology, robotics, biotechnology, new energy vehicles, among others. The aim is to reduce China's dependence on foreign technology and encourage innovation and the development of high-quality products within the country.
The plan also aims to increase domestic content in key components and materials to 70% by 2025. It is an effort to position China not only as a global competitor, but as a leader in advanced technological industries, with a view to having a dominant position in the global market by 2049, the 100th anniversary of the People's Republic of China (*The Diplomat*) (FDI China).

[4] China's Belt and Road Initiative (BRI).
The BRI is an ambitious plan to develop new trade routes connecting China to the rest of the world. The initiative is much more than infrastructure. It is an effort to develop an expanded and interdependent market for China, to grow China's economic and political power, and to create the right conditions for China to build a high-tech economy.
https://www.chathamhouse.org/2021/09/what-chinas-belt-and-road-initiative-bri

[5] https://www.catedrachina.com/single-post/tercer-foro-de-la-franja-y-la-ruta-para-la-cooperación-internacional

[6] WHITE HOUSE. *Fact sheet: one year after the CHIPS and Science Act*. Washington, 9 August 2023. Available from: https://www.whitehouse.gov/briefing-room/statements-releases/2023/08/09/fact-sheet-one-year-after-the-chips-and-

and committed $52.7 billion for research, development, production and job training in the semiconductor sector in the country.

This law imposes a wide range of prohibitions, restrictions and precautions regarding the export of chips, production equipment, design technology, etc. to China, and even affects US citizens who would like to work in the Chinese technology sector.

The new law meant that, in its outward technology policies, Washington reacted by adopting what has been called a "small yard, high fence" approach, i.e. using export controls and similar tools to limit Chinese companies' ability to access critical technologies such as artificial intelligence (AI) chips and semiconductor manufacturing equipment.

Over the past two years, the US has been stepping up this stance, tightening controls, closing loopholes found in the previous set of export restraints, expanding licensing requirements and subjecting more Chinese companies to trade restrictions, thus extending a policy that China had already described as a "technology blockade" and now describes as "economic warfare". This description is not really an overreaction: the main aim of the set of export controls is not so much to protect American industry or to stop the leakage of intellectual property to its competitor, but rather to break China's semiconductor industry by slowing down (or preventing if possible) China's path towards technological self-sufficiency.

However, this policy of research and production subsidies and export controls carries wide-ranging risks. China has responded by imposing its own export restrictions on key materials in semiconductor and electric vehicle production and has in turn limited access to the Chinese market for US semiconductor manufacturers.

Moreover, US efforts to repatriate production are hampered by its own bureaucracy. With legal problems over the environmental impact of new production sites and a lack of staff to process hundreds of project proposals, none of the funds allocated by the CHIPS and Science Act had been disbursed a year after its passage. [7]

science-act-biden-harris-administration-marks-historic-progress-in-bringing-semiconductor-supply-chains-home-supporting-innovation-and-protecti

[7] WHITE HOUSE. *FACT SHEET: CHIPS and Science Act Will Lower Costs, Create Jobs, Strengthen Supply Chains, and Coun- ter China*. The White House, 2022. Available at https://www.whitehouse.gov/briefing-room/statements-releases/2022/08/09/

It is worth highlighting the aspect of the ban on Chinese nationals working in Chinese technology companies because this is actually a crucial element. China has been recruiting specialised personnel from the US, Korea, Taiwan and Japan. These highly qualified personnel are essential in production and by cutting off this possibility it is also intended to prevent the transfer of *know-how.* The ban, however, only applies to US citizens, so the system has obvious loopholes.

Meanwhile, the domestic semiconductor industry faces a skills problem: not enough Americans have the necessary level of training in STEM fields[8] , and to make matters worse, the US loses many of the international students it trains with that profile to Australia, Canada, the UK and other countries whose talent visas (Talent VISA) are more generous and less cumbersome to process than the ones they offer.

Washington's technology strategy focuses only narrowly on domestic investment, ignoring the fact that real competition is developing beyond the borders of the US and China. Technology ecosystems, not domestic industries, are the real competitors. US success, therefore, depends not only on domestic innovation and production, but also on the choices made by companies and investors in Germany, India, Israel, Japan, Mexico, Saudi Arabia, South Korea and elsewhere around the world. To strengthen and integrate these critical components of its broader ecosystem, Washington needs to both invest directly and encourage private investment in technology development abroad; funds are needed to build research partnerships, resilient supply chains, and a network with the resources and innovation capacity to lead the world in the technologies of the future. This difference with the Chinese model is both a strength and a weakness for the Americans.

Evolution of technological competition for leadership

Until recently, indeed until the end of the last decade, the US led comfortably in innovation and technological development, while China seemed content to follow in its footsteps. However, China’s rapid ascent—set in motion by Deng Xiaoping’s reforms and consolidated under Xi Jinping—has reshaped the playing field. While doubts remain

[8] STEM is an acronym that refers to the academic disciplines of Science, Technology, Engineering and Mathematics. These areas of study encompass a wide range of fields that focus on problem solving, innovation and technological advancement, and are fundamental to progress in modern society and the economy.

about the full extent of China's technological advances, what is undeniable is that it now poses the greatest challenge to US primacy.

This shift marks a new era in Sino-US relations. After the fall of the Berlin Wall, Washington sought to incorporate Beijing into a rules-based global system and supported its entry into the WTO. But over time, ideological and strategic differences have stoked tensions, transforming what was once a constructive relationship into an unrelenting rivalry.

For years, multiple voices, from former senior US military commanders to a plethora of reports from independent *think tanks*, have warned about China's growing technological capabilities. The conclusion is unanimous: China is surpassing the United States in strategic areas that could make it the dominant power in defence, robotics and artificial intelligence in the near future.

A comprehensive new study by the Australian Strategic Policy Institute (ASPI)[9] has put numbers to these concerns: China is already ahead of the US in 37 of the 44 strategic technologies analysed, covering sectors as diverse as space, energy and quantum computing. These are not just current technologies, but those in which their advances will define the coming decades.

The ASPI report, which analyses high-level scientific research and production conducted in several countries between 2018 and 2022, offers a disturbing picture for Americans. According to the authors, "Western democracies are losing the global technology competition." China has laid the groundwork to become the dominant technological superpower, with a striking lead in most emerging disciplines.

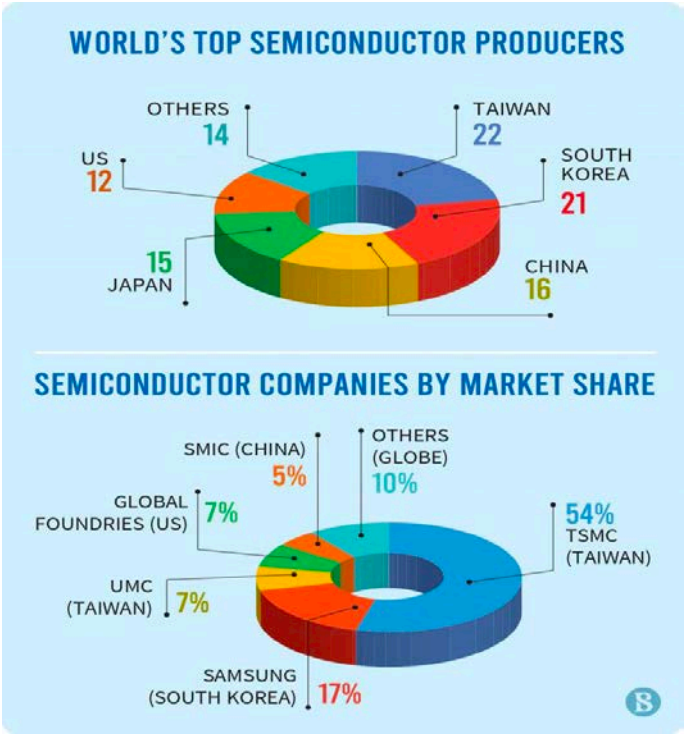
China's leadership is being consolidated in particularly sensitive areas, such as the development of hypersonic military technology. The country is home to seven of the ten most advanced research institutes in this field, a fact that underlines its intention to challenge US military superiority.

The US Department of Defence has already warned about this issue in its 2022 annual report[10] on China's military and security developments. According to the report, China's

[9] The Australian Strategic Policy Institute (ASPI) is a leading Australian-based *think tank* that focuses on issues of security policy, defence and international strategy. ASPI conducts research, analysis and policy advocacy on issues related to Australia's national security, regional and global geopolitics, and other strategic issues.
[10] https://www.defense.gov/Spotlights/2022-China-Military-Power-Report/ VIII.

hypersonic capability is extremely advanced, a fact that is seen with the deployment of the DF-17 medium-range ballistic missile equipped with a hypersonic glide vehicle (HGV), capable of transforming the Chinese People's Liberation Army Missile Force. This system, operational from 2020, is designed to strike military bases and fleets in the Western Pacific.

In its attempt to curb China's technological rise, the US has implemented a series of measures aimed at cutting off Beijing's access to key technologies, particularly in the semiconductor and artificial intelligence fields as detailed in the previous chapter. At the heart of this strategy is the restriction of Chinese access to state-of-the-art microchips, essential for any breakthrough in these fields. Although sanctions and blacklists have proven effective in specific cases, such as that of Huawei[11] (see next chapter), they have so far failed to halt China's technological progress and that of its main companies.



Source: Brooking Institution

Image2 . Who's who in the world of semiconductors

[11] See section 4 in this chapter.

The US administration has focused on limiting the export of machinery needed for the production of advanced microchips. In the autumn of 2023, Washington passed a series of restrictions to complement the CHIPS and Science Act, including a ban on US companies manufacturing chips with nodes smaller than 28 nanometres in China and Russia for the next decade. This is crucial, given that the most advanced chips are manufactured at 3 to 5 nanometre scales. These restrictions and limitations on China and Russia could become even more effective after the accession of Japan and the Netherlands.

		release year	logic node	Memory node	Overlay (nm) SMO	MMO	MMO to EUV	Lens NA	Resolution (nm) @ k_1=? 0.35	0.25
no longer offered	XT:1700i		45nm					1.2	56	40
	XT:1900i		32nm		4.6			1.35	50	36
	NXT:1950i	2009	20nm			5.5				
	NXT:1965Ci	2013	20/14nm	3D NAND	2.5	4.5				
	NXT:1970i	2013	14nm			3.5				
blocked	NXT:1980Di	2015/6	10nm	18nm DRAM	1.6	2.5				
	NXT:2000i	2018	7nm			2.5				
	NXT:2050i	2021	5nm				2.5			
	NXT:2100i	2023/4	2nm		0.9	1.3				

Source. Reuters

Image3 . ASML equipment banned/authorised for export to China

The critical role of Japan and the Netherlands

The importance of these new allies lies not so much in the size of their economies, but in the key technology companies they host. The Netherlands is home to ASML[12] , the only company in the world capable of building extreme ultraviolet lithography equipment, indispensable for producing next-generation microchips. Without access to this technology, China's ability to manufacture chips below 10 nanometres is severely limited, affecting its ability to develop crucial technologies such as mobile phones, computers and especially the data centres and supercomputers needed for the development of artificial intelligence.

[12] ASML is a Dutch multinational company specialising in the manufacture of lithography equipment used in the production of silicon chips. Its lithography systems are essential in the manufacture of advanced semiconductors and are used by leading chip manufacturers worldwide. ASML is a leading supplier of equipment to the semiconductor industry.

Japan, although overtaken in the semiconductor market by South Korea, remains a key player in the production of deep ultraviolet lithography equipment, the second most advanced technology in this field. In addition, Japanese companies such as Nikon and Lasertec are crucial in this sector, as is the Ajinomoto Group, which is the world's only supplier of an essential resin for semiconductor production, Ajinomoto Build-up Film (ABF).[13]

While it is foreseeable that both Tokyo and The Hague will tighten their stance on technology exports to China, it is unclear whether these controls will reach the level of strictness applied by the United States.

The first battle: HUAWEI as a paradigmatic case

Concerns about Chinese telecommunications companies, and Huawei in particular, began in 2007, when Huawei and Bain Capital's investment in 3Com Corporation, a US digital electronics company, was investigated by the US Committee on Foreign Investment (CFIUS). This was because 3Com provided cybersecurity systems to its SAFs. When CFIUS announced that it would recommend to the president to block the deal, the Chinese withdrew the investment. In 2011, Huawei also abandoned its acquisition of the US server company 3Leaf, which it had agreed to buy for $2 million, due to the expectation of a presidential veto after a CFIUS review indicated that the deal should not proceed.

In response, Huawei published an open letter inviting the US government to conduct "a formal investigation into any concerns it may have about Huawei in order to reach a clear and accurate conclusion" (2011). This led to an investigation by the House of Representatives, which concluded in 2012 that "the United States should view with suspicion the continued penetration of the US telecommunications market by Chinese telecommunications companies"[14] .

[13] ABF is a type of resin material used in the production of semiconductor chips. It is a crucial component in the process of building layers on a chip substrate, which is essential to the miniaturisation and increased complexity of modern integrated circuits. ABF serves as an insulating layer and a dielectric material that aids in the wiring and packaging of semiconductor chips, enabling the development of more powerful and efficient processors. This material has been and is central to the advancement of computer technology, especially in the production of CPUs and GPUs for computers and other electronic devices.

[14] https://intelligence.house.gov/sites/intelligence.house.gov/files/documents/huawei-zte%20investigative%20report%20(final).

This report was a milestone in the growing tension between the US and China in the area of technology and telecommunications and remains relevant in current discussions on cybersecurity and China's technological influence. Although the report focused on US security, it had a significant impact globally, as other countries also began to review their relationships with Huawei and ZTE based on security concerns.

By that time, Huawei had already built a global business. In the late 1990s, the company was identified as a "national champion" by the Chinese government, which gave it access to low-cost financing, research and development funds, and tax benefits. Huawei grew to become the dominant telecommunications company in China and, by 2001, had offices in 45 countries, including the United States. By 2012, it had overtaken Ericsson and Nokia to become the largest information and communications technology (ICT) infrastructure provider in the world. By 2019, it had a 27.5% share of the global market for 5G base stations, which provide wireless coverage and signal transmission between the wired communication network and the wireless terminal. In 2020, it overtook Ericsson to become the world's leading supplier of 5G base stations.

The Trump administration focused its restrictive measures on Huawei because of a combination of its focus on global telecommunications technology and its close relationship with the Chinese state, making it both an economic and (above all) a security threat to Washington.

In 2019, Christopher Ford, Assistant Secretary of State for International Security and Non-proliferation, nominated Huawei for inclusion on the Department of Commerce (DoC) Entity List. This listing meant that it would be required to have a specific licence to export items on the Commerce Control List (CCL), a list of dual-use items subject to the Export Administration Regulations (EAR).

In addition, a major diplomatic effort was undertaken to convince other countries not to use the Chinese company's equipment to build their national 5G networks. In January 2020, Secretary of State Pompeo announced that "we are warning our allies and partners about the enormous security and privacy risks associated with allowing Huawei to build its 5G networks in their countries[15](Pompeo, 2020).

[15] https://www.infobae.com/america/mundo/2020/04/29/mike-pompeo-sobre-el-5g-seguiremos-haciendo-todo-lo-que-podamos-para-proteger-nuestra-informacion-de-manos-del-partido-comunista-chino/

The State Department began compiling the list of "Clean 5G Countries", i.e. states that "are choosing to allow only trusted vendors on their 5G networks instead of Huawei", and "Clean 5G Telecommunications Companies" that "are refusing to do business with tools of the Chinese Communist Party's surveillance state, such as Huawei"[16] .

In addition, comprehensive sanctions were imposed on Huawei that virtually cut off the company's direct access to critical dual-use items it needed to import from the United States. As of May 2019, a licence was required to export anything subject to dual-use export controls from the United States to Huawei or its affiliates, or to export anything from another country that had a certain level of content controlled by the US export department or was produced because of export-controlled US-origin technology.

While there were no 5G network equipment manufacturers in the United States that could compete with Huawei, many US companies supplied the company with essential high-end parts, such as advanced semiconductors, *software* and switches, that it could not source locally. In 2018, 33 of its 92 suppliers were US companies and Huawei was buying about $11 billion in supplies from US companies. The sanctions were specifically designed to affect the most valuable chips for its 5G and its most sophisticated *smartphones*. In the first year of sanctions, they affected 1,200 US suppliers of components and intellectual property and sixty-eight of their subsidiaries (biblio 5).

However, Huawei found a partial way around the sanctions by ordering its production from foreign foundries that used US equipment. In May 2020, the DoC[17] closed this loophole by expanding the "foreign direct product" export control rule, meaning that companies anywhere in the world needed a US licence to sell a finished product to Huawei if its manufacture involved any US *software*, design or manufacturing equipment. This was approved to affect products such as semiconductor designs that are the direct product of a particular *software* and technology on the Commerce Control List (CCL) and items such as *chipsets*, when are produced from the design specifications of Huawei or an affiliate on the Entity List.

As a result of that second round of sanctions in 2020, the disengagement between Huawei and US 5G-related technology became a reality. The immediate victim was the

[16] https://2017-2021-translations.state.gov/2020/08/11/la-iniciativa-red-limpia-protege-los-activos-de-estados-unidos/
[17] Department of Commerce.

company's *smartphone* business. In August 2021, Huawei launched new smartphones with 4G-only capability and without the Android operating system, in contrast to its 2019 Mate 30 series, which featured a 5G *chipset* and an integrated 5G modem. Huawei's share of the global *smartphone* market fell from 18.4% in the second quarter of 2020 to 8.9% in the fourth quarter and dropped to 3.6% in November 2023. In 2021, Huawei's consumer sales revenue declined 49.6%, with a further 11.9% drop in 2022. The company experienced its largest drop in operating profit in 2021, reflecting the damage inflicted on its *smartphone* business by sanctions.[18]

But on the other hand, Huawei's ICT infrastructure business seems to have withstood the sanctions better. By the end of 2022, the company held a 29% share of the global 5G base station market, with Ericsson at 24% and Nokia at 21.5%. Huawei does not provide specific data on 5G base stations but reports annually on the performance of its carrier business, which includes most of its ICT infrastructure[19] . In 2020, this business was slightly ahead of 2019, with a 0.2% increase in revenue. In 2021, it generated 7% less revenue but was Huawei's most profitable division. In 2022, revenue from the carrier business increased marginally by 0.9%, remaining Huawei's largest source of revenue.

Huawei has continued to sign contracts for 5G infrastructure with telecommunications companies on every continent. As of February 2023, 81 countries outside China were using Huawei equipment to build at least part of their 5G infrastructure. This includes: 18 countries in Europe, of which 10 are NATO allies (Germany, Hungary, Iceland, Italy, Latvia, Montenegro, the Netherlands, Portugal, Spain and Turkey); 28 countries in Asia, including three allies that have treaties with US (Philippines, Thailand and South Korea); as well as large markets such as Brazil and Russia.

Among US allies, the collaboration with Huawei varies. In Turkey and Hungary, Huawei will build the entire 5G network. In Germany, it provides more than half of the infrastructure connecting *smartphones* to the 5G network. Italy, Portugal, Iceland, Spain and the Netherlands also use some Huawei equipment. In Asia, telcos in the Philippines use Huawei equipment extensively; in Thailand, Huawei began 5G trials in 2019; and

[18] HUAWEI Annual Report.
[19] https://www-file.huawei.com/-/media/corporate/local-site/ie/pdf/5g-future-huawei-report.pdf

even in South Korea, where the 5G infrastructure market is dominated by Samsung, the smallest operator, LG U+, uses Huawei equipment for its 5G network.

In contrast, only nine countries have banned Huawei equipment altogether: the US, Canada, the UK, Australia (four of the five members of the Five Eyes intelligence alliance[20]), as well as Japan, Luxembourg, Poland, Romania and Sweden. Even among close allies there was initial resistance; for example, the UK reversed an earlier decision to allow Huawei to operate in July 2020 after months of pressure from Washington. France appears to want to phase out Huawei equipment by 2028, although there is no total ban. Four other countries have implemented restrictions (New Zealand, Belgium, Czech Republic and Lithuania). A total of 77 countries have not yet considered or decided on 5G infrastructure. However, 45 of them have signed contracts with Huawei in the past for other aspects of their telecom's infrastructure, such as 3G or 4G, making it more likely that they will choose to continue with compatible Huawei equipment in the future. All these 45 countries are "developing countries", for which Huawei's lower prices are presumably more attractive.

[20] "Five Eyes" is an intelligence alliance between Australia, Canada, New Zealand, the United Kingdom and the United States. These countries cooperate in the collection, analysis and exchange of intelligence information, particularly related to national security and surveillance. The alliance was established during the Cold War and has remained an important part of intelligence cooperation between these nations to the present day.

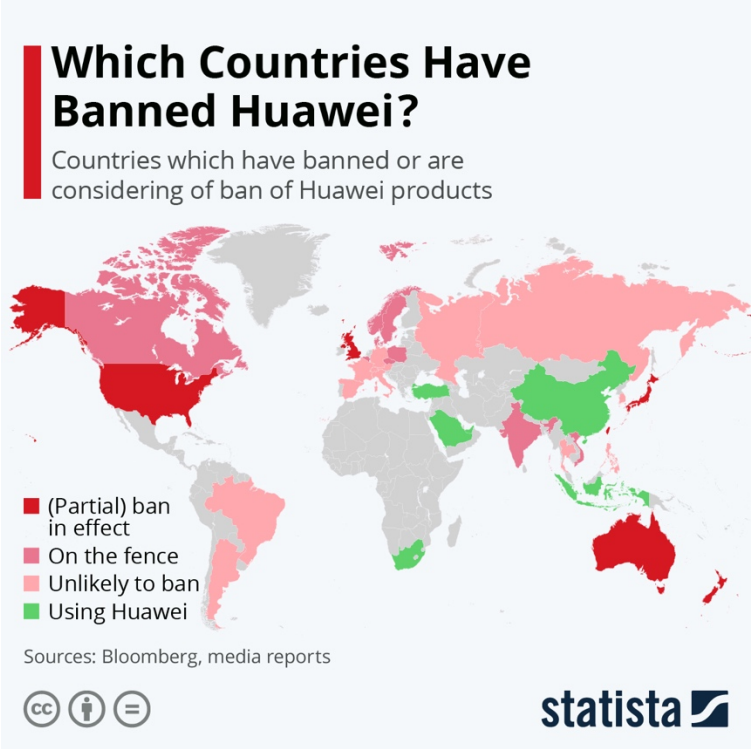


Image4 . Countries that ban or are considering banning Huawei

Given Huawei's reliance on high-end semiconductors with US content, this result may seem surprising. However, the company has maintained its share of the base station market in several ways. First, it rapidly accumulated a large number of components. Each sanctions announcement included a grace period that allowed it to fulfil existing orders and gave US companies time to adjust. For the May 2020 sanctions, which were the most damaging to Huawei, this period was extended to 14 September 2020. Before the deadline, Huawei ordered 2 million base station chips from TSMC Taiwan to maintain production after the ban went into effect. In addition, the US Department of Commerce issued a temporary general licence in May 2019 that allowed certain transactions with Huawei "to ensure the continued safe and secure operation of parts of telecommunications systems, while allowing affected companies and individuals time to identify and switch to other sources of equipment, *software*, and technology". This licence was extended five times until 13 August 2020, likely enabling Huawei to further build up its stock of components for 5G base stations.

The strategic awakening of the United States

Although Huawei's 5G business appears to have held up, the Biden administration has extended sanctions to other companies. This followed intelligence warnings that China was using artificial intelligence and supercomputing to develop hypersonic weapons and potentially decrypt the U.S. government's most secret messaging system.

In early October 2022, the US Department of Commerce (DoC) announced that it would expand the scope of the restrictions. In December, 36 new companies were added to the Entity List, including Yangtze Memory Technologies (YMTC), China's largest producer of memory chips; Cambricon, a leading chip design company, along with nine of its subsidiaries; and Shanghai Microelectronics Equipment Group, a chip tool manufacturer. According to the DoC, the listed entities "are significant in the research, development, manufacture and sale of artificial intelligence (AI) chips... [with] close ties to government organisations that support China's military and defence industry".

In addition, a new "export rule", issued in October 2022, introduced several additional changes. More items were added to the Commerce Control List (CCL), including more advanced microchips, products containing such chips, and more semiconductor manufacturing equipment. The "foreign direct product rule", used against Huawei in 2020, was further expanded to cover a broader range of items destined for China, including those for use in supercomputing and in the development or production of semiconductors or equipment to manufacture them. US companies were expressly prohibited from supporting the production of microchips in China. This action was taken in response to news in July 2022 that Chinese chip developer SMIC[21] had produced a microchip that competed with the complex chips made in Taiwan by TSMC, which led the Biden Administration to seek further restriction on exports to China.

The US companies affected include chip design leaders Nvidia and AMD, and tool makers such as Applied Materials and Lam Research. As for Chinese companies, the controls will affect SMIC, YMTC and Chang Xin Memory. The justification was based on "direct national security concerns".

[21] Semiconductor Manufacturing International Corporation (SMIC) is a leading semiconductor manufacturing company based in China. SMIC is one of the world's largest foundries of integrated circuits and offers chip fabrication services for a wide range of applications, from consumer electronics to industrial equipment. The company has been a major player in the semiconductor industry and has played a crucial role in the global chip supply chain.

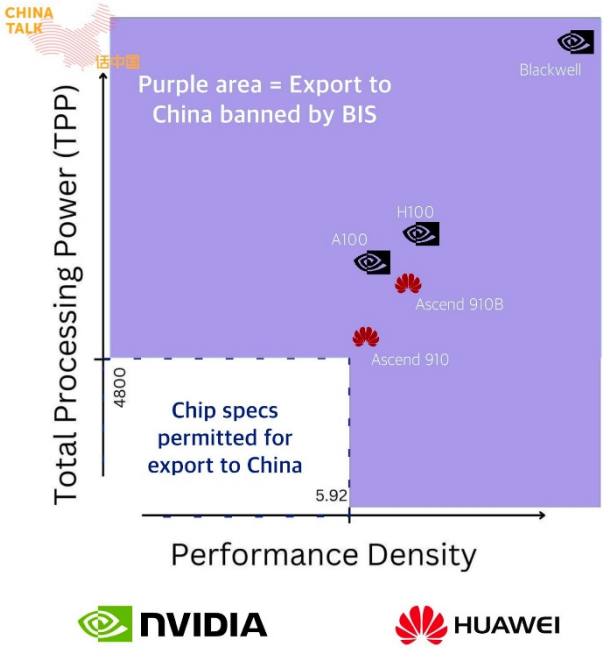
The Biden administration is fine-tuning even stricter regulations, according to information reported by *Reuters* and *Bloomberg*[22] . A preliminary draft proposes adding around 120 Chinese companies on the list of entities, which would require other companies to obtain a special licence to export products to them from the US. The list would focus on firms involved in chip manufacturing, chip production machinery and support services.

In addition, certain Chinese chip manufacturers could face international restrictions that would limit access to equipment made with US technology or components, even if sourced from third countries. Potentially affected companies include Chinese factories allegedly linked to Huawei, such as SwaySure, Shenzhen Pensun Technology, Pengxinwei IC and Qingdao Si'En.

Further restrictions on memory chip shipments, which are crucial for training AI models, are also under consideration. Stricter thresholds for AI chips produced by Nvidia and other companies have been discussed.

The regulatory overhaul aims to close loopholes that allow US companies to circumvent restrictions by shipping products to China from subsidiaries in countries such as Israel, Malaysia and Singapore.

[22] https://www.nytimes.com/2024/08/09/business/economy/china-us-chip-semiconductors.html



Source: Statista.

Image5 . NVIDIA/Huawei processing power share

The effectiveness and risks of restrictions

The imposed restrictions, while aimed at slowing China's advance, could have adverse effects. If these new controls prove fully effective, they could significantly hamper China's ability to develop advanced computing tools or facilities needed to train artificial intelligence systems. However, these measures will likely cause China to redouble its efforts to achieve technological self-sufficiency.

The truth is that China has already demonstrated its ability to advance chip production despite the restrictions. A TechInsight report[23] from 2022 stated that SMIC, China's largest chip foundry, may be secretly producing components at the 7-nanometre node. This caused deep concerns in the West[24] . If China manages to consolidate this breakthrough, it could be self-sufficient in the most advanced technology and remain competitive in the race for artificial intelligence, at a lower cost of performance.

[23] TechInsights is a Canadian provider of semiconductor-related intellectual property and analytics services to technology companies and other subscribers. It is known for its reverse engineering capabilities.

[24] https://asiatimes.com/2022/07/smics-7-nm-chip-process-a-wake-up-call-for-us/

Restrictions are also a double-edged sword for the semiconductor industry in general. The latest round of US restrictive measures caused a drop in the value of the US companies involved, reducing their capitalisation by USD 240 billion. The US Semiconductor Industry Association (SIA)[25] has warned that companies in this sector need to invest one-fifth of their turnover in research and development—one of the highest rates in any industry—meaning these restrictions directly impact their ability to innovate.

Despite Washington's efforts, the success of this strategy remains to be seen. The secondary market remains an escape route for China to obtain advanced components. In January 2023, the *Wall Street Journal* revealed how the Chinese Military Academy, central to China's nuclear programme, managed to acquire components from Intel and Nvidia, despite being under sanctions for more than two decades[26] . This underlines the difficulties of implementing effective controls in such a complex environment.

China leads not only in military technology, but also in eight key fields of the energy industry, including hydrogen power generation, supercapacitors, electric batteries, photovoltaics, nuclear waste management, biofuels, nuclear power and direct energy technology (lasers, microwaves and sound waves). While the US remains the leader in quantum computing, China has already overtaken it in quantum cryptography, quantum communications and quantum sensors. The US containment strategy is a direct response to this reality and to the growing threat in other sectors.

China's strategy: state capitalism, repatriated talent and the benefits of open sourcing.

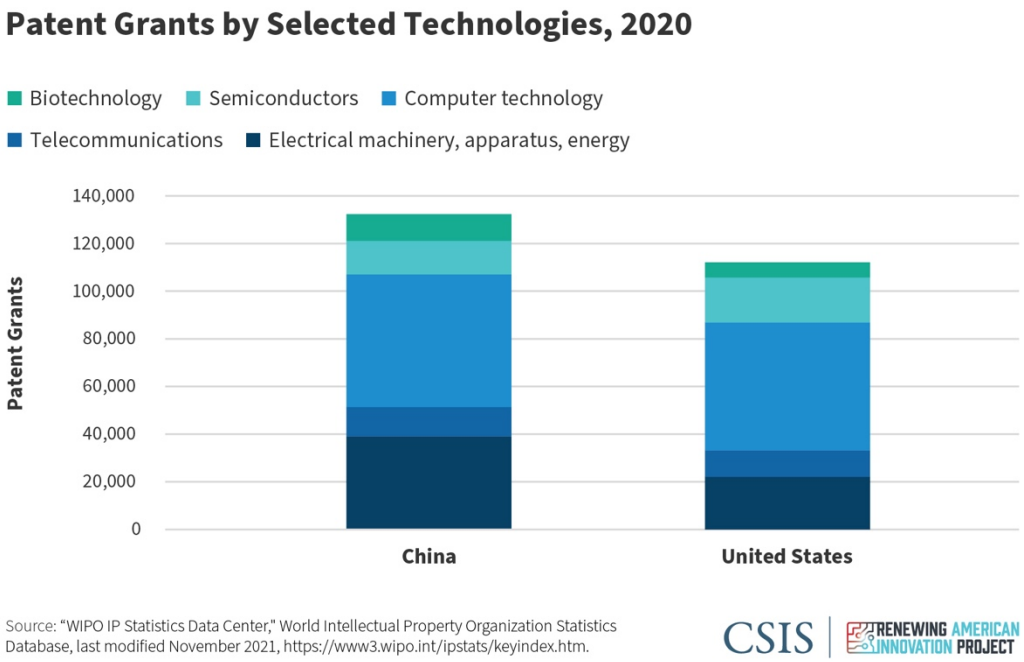
Sharpening your wits

China's rapid progress over the last decade has been based on a clear formula: massive investment in technological research and the development of the talent needed to realise these advances. Since 2011, China has surpassed the United States in the annual

[25] The Semiconductor Industry Association (SIA) is a trade association representing semiconductor manufacturing companies in the United States. The SIA advocates for government policies favourable to the semiconductor industry, promotes technological innovation, and provides data and information on trends in the semiconductor industry. The organisation plays a crucial role in defending the interests of semiconductor companies and promoting growth and competitiveness in the semiconductor industry.

[26] https://www.wsj.com/articles/chinas-top-nuclear-weapons-lab-used-american-computer-chips-decades-after-ban-11674990320?mod=djemalertNEWS

number of patents, and ten years later, according to CSIS data[27][28] , it is already double its rival. Moreover, Beijing has launched an aggressive campaign to repatriate foreign-trained scientists and researchers. In 2021, more than 1,400 scientists left their posts in the US to return to China.[29]



However, the road from research to commercialisation is long and complex, and China still has many problems to solve before it can turn its patents into viable and commercially successful products. Nevertheless, Washington has reason for concern. Public-private collaboration in China is less complicated than in many Western countries, and Chinese state capitalism is proving capable of innovating, sometimes more effectively than market capitalism.

n China's tech industry, there is a growing belief that open-source technology could be a catalyst for development, even in the face of US restrictions. Indeed, if US regulators were to decide to slow the advance of US-led open-source projects, China could gain a significant strategic advantage. In such a scenario, if the most advanced open-source

[27] The Center for Strategic and International Studies (CSIS) is a Washington, D.C.-based *think tank* that focuses on foreign policy, national security and international affairs. CSIS conducts research, analysis and offers policy recommendations in a wide range of areas, including cyber security, global economics, energy security and international stability. It is an institution recognised for its influence in the field of foreign policy and security.
[28] https://www.csis.org/analysis/what-can-patent-data-reveal-about-us-china-technology-competition
[29] https://foreignpolicy.com/2023/07/13/chinese-scientists-united-states-research-tech-academia-china-initiative/

technologies were to come from China, US developers might be forced to build their systems on Chinese technological foundations.[30]

The United States forged its leadership in artificial intelligence through collaboration between companies and academics, a model that China could replicate. Open-source artificial intelligence, considered the foundation of development in this field, plays a crucial role in this dynamic. While anyone with a computer can modify the code of open-source *software*, fundamentally altering an artificial intelligence system requires vast resources in terms of data, skills and computing power. In the context of artificial intelligence, open source implies that the basic components of a system act as a platform that allows others to build on top of it.

China's dominance in artificial intelligence is evident: companies such as Tencent and Baidu lead in the number of patents in this field, far outpacing Western giants such as IBM, Microsoft and Alphabet (Google). According to the ASPI report, China is already ahead of the US in seven of the top ten AI disciplines, including *machine learning*, advanced data analytics and AI algorithms. Although the US maintains the lead in supercomputers, next-generation processors and natural language processing, the gap is narrowing.[31]

China's technological rise is not just a matter of numbers and patents, but a paradigm shift that challenges Western assumptions about innovation and progress. China's ability to combine state power with market-driven creativity is reshaping the global technology landscape, and the US will have to adapt quickly if it wants to maintain its leadership.

Innovation with State control

Beijing, aware that technology is the new battleground, has redoubled its efforts to reduce its dependence on the West. Under the "Made in China 2025" strategy and the "Digital Silk Road" initiative, the Chinese government has designed an ambitious plan to become a technological superpower while maintaining internal sector leadership.

[30] https://www.france24.com/es/minuto-a-minuto/20240704-el-primer-ministro-chino-pide-cooperación-internacional-en-materia-de-ia

[31] https://www.nytimes.com/2024/07/25/technology/china-open-source-ai.html

Let us analyse these policies in more detail along their most significant lines:

Increasing the technology base. In the face of US pressure, China has adopted a comprehensive strategy, encouraging the growth of thousands of "little giants"—specialised companies with the potential to master critical technologies. Managed by the Ministry of Industry and Information Technology, this approach aims to resolve technological bottlenecks and ensure leadership in key sectors.

China's state support programmes are nothing new, but its approach has become more sophisticated and ambitious in recent years. Since 2016, Beijing has accelerated its efforts to strengthen technological self-sufficiency, in response to Xi Jinping's directives to reduce the country's reliance on foreign technology. These programmes, inspired by German scholar Hermann Simon's concept of "hidden champions"[32] , have been adapted to foster small and medium-sized enterprises to emerge as global leaders in technological niches.

In this context the two flagship programmes: the "Small Giants" and the "Individual Champions" are interdependent and aim to identify and support companies that already have, or are on the way to achieving, a dominant position in key technologies. These initiatives currently benefit some 10,000 companies.

About 30% of the "individual champions" identified in recent years emerged from the "little giants" programme, suggesting that the strategy is bearing fruit. China has focused on sectors where it already possesses significant capabilities and where it can gain competitive advantages more quickly.

Tightening State control over technology. Despite the success of private tech giants such as Alibaba and Tencent, the Chinese government has tightened its control over the country's technological direction. Beijing's approach prioritises industrial security and global influence, often over economic efficiency, a shift that reflects a growing distrust of globalisation in critical technology areas and has allowed it to increase its efforts in a single direction.

[32] The concept of "hidden champions" was introduced by the German academic Hermann Simon to refer to relatively unknown companies that are world leaders in their respective markets, often in niche segments. These companies often perform exceptionally well in terms of innovation, quality and exports, despite not being internationally famous. Hidden champions" often have a long-term approach, a focus on excellence and a commitment to continuous innovation. Hermann Simon has extensively studied and documented these types of successful companies in various industrial sectors.

Several examples illustrate the implementation of the "Chinese model":

One notable beneficiary is GRIPM Advanced Materials Co., a company specialising in advanced metal powders, crucial for the manufacture of aerospace components through 3D printing. Controlled by a Chinese state-owned company, GRIPM dominates almost 38% of the global market for these powders, an achievement made possible by the strategic acquisition of UK-based Makin Metal Powders in 2015.

Another example is Ningbo Yongxin Optics Co., which produces lenses used in satellites and in microgravity experiments on board the Chinese space station. ComNav Technology Ltd. has become a key player in the manufacture of chips and circuit boards for satellite navigation systems, competing directly with foreign suppliers. Both are controlled by government-owned companies.

As seen, China's strategy goes beyond simply competing; it is about creating a self-sufficient, state-controlled technological ecosystem that can challenge Western dominance in critical sectors.

A commitment to self-sufficiency. China's push for self-sufficiency in the tech sector is a deliberate strategy to secure its position as a leader in the global economy of the future. This approach not only seeks to protect the country from fluctuations in international relations and geopolitical tensions but also aims to put China at the forefront of global innovation, redefining the balance of power in the 21st century.

One example is Aluminium Corp. of China Ltd., one of the world's largest aluminium producers. The company has increased its production of high-end aluminium, crucial for the defence industry, an area where China remains a net importer. This commitment to self-sufficiency in key sectors reflects Beijing's strategy to reduce its dependence on imports in critical technologies.

The global expansion of Chinese technology

Through a strategy of direct commercial engagement, China has successfully promoted the adoption of its technology worldwide, particularly in countries of the so-called Global South. The Chinese state has deployed a combination of financial aid and technical

assistance to encourage the purchase of Chinese *hardware* and *software*, achieving notable success in Africa, Latin America, Southeast Asia, and the Middle East.

This advance has not been merely commercial; it has had profound political implications. In many of these regions, Chinese technology has been instrumental in enabling their governments to strengthen their control over access to information and surveillance of their populations. As a result, the ideal of a global and open internet has been replaced in many parts of the world by a fragmented system, controlled by authoritarian states that have adopted China's digital tools.

Over the next decade, even the largest US technology companies will find it difficult to compete with their Chinese rivals. While still leading the way, both domestically and internationally, Western companies find themselves at a growing disadvantage. China's unfair trade practices, including massive subsidies, regulatory support and forced technology transfer, have given its companies a significant advantage, even in developed and wealthy markets.

The qualitative rise of Chinese technological capabilities has led to a situation in which, sector after sector, Chinese companies are capturing an increasing share of global welfare:

In April 2024, G42, a large UAE-based AI company, signed a $1.5 billion partnership with Microsoft. This deal followed months of quiet pressure from US national security officials, who pressured the company to reduce its ties with China and maintain access to critical US technology, including Nvidia chips. Subsequently, an investment entity under the supervision of the Emirati National Security Advisor took control of G42's fund, which holds stakes in Chinese tech giants such as ByteDance and JD.com. In May, Saudi Aramco's venture capital fund participated in a $400 million funding round for Zhipu AI, China's largest generative AI *startup*, which aims to compete with OpenAI.

These moves illustrate a shift in the geopolitical landscape, with influential middle powers increasingly rejecting the notion that maintaining strong relations with both the West and their strategic adversaries is mutually exclusive.

The keys for the West: maintaining strategic advantage.
What should be the strategic objectives in this conflict?

In the face of this challenge, the West, and particularly the United States, must consider three key objectives in its strategy to compete with China.

First, preserving its edge in technological development and innovation requires a clear analysis of its own capabilities with a large dose of reality and pragmatism. It will also require recognition of one's own limitations (the US will not be able to continue to lead in all facets of the multiple technology sector) and a clear determination of which technologies are critical to national security and to focus on them.

Second, being able to maintain international cooperation in trade and science, an area that risks being undermined by the growing rivalry between the two countries. The degradation of scientific cooperation and the fragmentation of the global trading system are real threats that could have medium to long-term consequences for innovation, global economic growth or the agreement of international rules to regulate a sector in dire need of standards and ethics.

Third, align its strategy with that of its allies and partners, recognising that, while they share common interests, they do not always coincide in all respects. Coordination with allies is crucial, especially as China aspires to technological self-sufficiency, while the United States relies on a network of global alliances. This has been posing a major dilemma for Asian allies, especially Japan and South Korea, because of their geographic proximity (and therefore commercial simplicity) to China. In the past year 2023 both countries have taken important steps in this direction by limiting and restricting the transfer of cutting-edge technology to China.

It is also essential to be able to attract the set of non-aligned countries that China has been courting so far and that need to see advantages in moving closer to the Western technological orbit.

The case of TSMC in Taiwan

As is well known, the island rests its security on engagement with the US for the security and defence of its republic against the aspirations of mainland China.

TSMC accumulates 60 % of the world's chip production in its factories in Taiwan.

It will open a plant in Arizona in 2024 in the heat of the CHIPS Act subsidies, albeit with limited capacity compared to those on the island. In August it opened another production site in conjunction with European companies in Dresden (Germany) (see 9.1 below) and is considering opening a second factory in the US and others in Japan and the Netherlands. This contributes to the American and European strategy on the need to relocate and repatriate part of the production concentrated in Taiwan.

China takes a dim view of any autonomous decision by Taiwan in its aspiration to integrate the island under its sovereignty. A military conflict over the island would seriously regional semiconductor production and there are currently no alternatives to TSMC.[33]

Some foresight

It is possible that, over the next decade, China will consolidate its technological leadership in many areas at the expense of the US and its allies. This scenario is not the product of historical inevitability, but of a series of strategic decisions that, cumulatively, are tipping the balance in Beijing's favour.

The result would be a world where the scientific and technological advantage that the United States has held from 1945 well into the 21st century has vanished. Chinese laboratories, universities and companies would now lead in announcing scientific discoveries and transforming them into commercially valuable technologies.

The strategic consequences of this shift would be profound. By 2030, China will not only have closed the defence spending gap, but could have reached or even surpassed the United States and its allies in the development of advanced weaponry. From Washington to New Delhi, there is growing concern about how China's technological might has altered the geopolitical balance in the Asia-Pacific region.

However, the military domain is not the only area where China has made progress. In the global market, Chinese technology companies are outperforming their Western

[33] IEEE Geopolitical Landscape of Conflict 2023, pp. 287-288.
https://publicaciones.defensa.gob.es/media/downloadable/files/links/p/a/pan_geo_conflictos_2023.pdf

competitors, including some of the largest and most influential US companies. The world's gaze, once focused on Silicon Valley, now turns with equal interest to Shenzhen, China's epicentre of technological innovation.

The impact of conflict: from global technological governance to normative fragmentation

China's growing power has also made it almost impossible for Western democracies to impose their preferences on global technological governance. China's influence in the development of technical standards within international organisations has grown significantly, challenging the West's ability to lead in this area.

Since the early 2020s, a lack of interest in scientific cooperation has prevented the US, Europe and China from agreeing on the basic rules and principles that should guide the development of high-risk technologies. This has resulted in a fragmented and incomplete governance architecture, with individual countries, companies and laboratories moving forward without a common ethical regulatory framework.

In areas such as artificial intelligence, China has intensified the use of applications that undermine individual rights and freedoms, such as state-controlled facial recognition technologies to monitor citizens' activities, not only within China but also in parts of the world that have adopted its technologies.

However, these concerns do not end there. Scientific collaboration between the United States and China—and by extension between China and many of the United States' allies—has declined dramatically since 2023. The cross-border cooperation that was once a pillar of global scientific progress has been replaced by an environment of mistrust and hostility, where the exchange of scientific knowledge is severely limited.

This fragmentation has undermined scientific progress in crucial areas, from cancer research to energy innovations, putting global progress at risk.

The scenario described above poses two main risks.

First, the risk of an excessive disconnect between the US and Chinese economies and technological systems, which could lead to a wider conflict between the geopolitical and economic goals of the two countries.

And there is also the risk of damaging global governance. If the strategic competition between the US and China continues on its current course, the global architecture guiding technological development could be seriously compromised, with negative consequences for international cooperation and innovation.

The European case: the European Chip Law.
Towards European digital sovereignty and strategic reindustrialisation

The pandemic has served as a stark reminder of the vulnerability of global supply chains, and Europe has not been immune to its effects. Shortages of manufactured goods, particularly semiconductors, have revealed the continent's critical dependence on external suppliers. This shortage, which began in 2020 and continues to affect various sectors, has prompted the European Commission to take steps to ensure resilience and self-reliance in an increasingly uncertain world.

Brussels' response came in February 2022 with the introduction of the European Chip Law[34] , an ambitious initiative designed to ensure security of supply and strengthen the EU's technological leadership in the crucial semiconductor sector. This package aims to double Europe's global market share from a production share of 10% today (2022) to 20% by 2030, mobilising more than EUR 43 billion in public and private investments.

The European Chip Law is not simply a response to semiconductor shortages; it is a central pillar in Europe's broader strategy to regain its industrial sovereignty. Globalisation and offshoring in recent decades have left the European Union exposed to disruptions in the supply of essential components such as microchips, which are critical to a wide range of industries from automotive to medical technology.

The Brussels plan is based on two key regulatory proposals. The first seeks to strengthen Europe's semiconductor ecosystem, building on the continent's strengths, such as its leading research and technology organisations and pioneering equipment manufacturers. The second proposal amends the regulation establishing the Joint Undertakings under

[34] https://www.boe.es/buscar/doc.php?id=DOUE-L-2023-81291

Horizon Europe, adapting it to support the Chips Joint Undertaking[35] , an entity designed to coordinate these efforts at the European level.

In addition, the European Commission has complemented these proposals with two *soft law* instruments[36] . On the one hand, a Communication urging the Council and the European Parliament to support measures to rapidly strengthen Europe's semiconductor capacity. On the other, a recommendation to Member States to collaborate through a European semiconductor expert group, facilitating the exchange of information and the coordination of responses to the current crisis.[37]

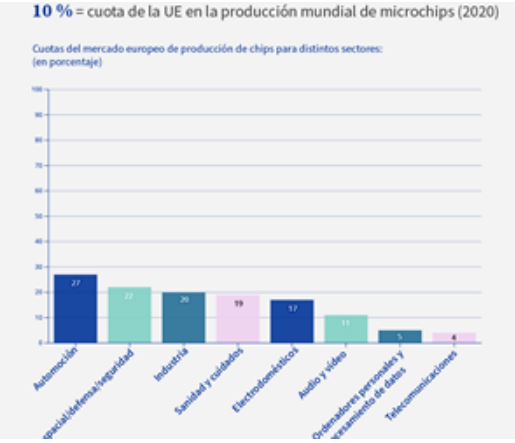
Some steps seem to be taking shape: on 20 August 2024 Commission President Von der Leyen inaugurated the European Semiconductor Manufacturing Company (ESMC), a joint venture between Taiwan Semiconductor Manufacturing Company (TSMC), Bosch, Infineon and NXP, funded by European grants, in Dresden. The facility is expected to operate at full capacity by 2029, producing 480,000 next-generation chips, used for automotive and industrial applications. Von der Leyen also announced that in her new mandate the Commission will take further steps to boost Europe's industrial competitiveness by creating a European Competitiveness Fund to invest in strategic technologies in the field of chips and AI.[38]

[35] The "Joint Undertaking for Chip and Battery Processing Equipment", better known as the "Chips Joint Undertaking". This initiative, established in Europe, aims to develop and produce advanced chips and fuel cells for energy and sustainable mobility applications. The Chips Joint Undertaking is part of the European Union's efforts to promote innovation and competitiveness in key sectors such as semiconductor technology and clean energy technologies.

[36] "Soft law refers to non-binding or non-binding rules that do not have the force of formal law, but can influence the behaviour and practices of the parties involved. These standards may include codes of conduct, guidelines, principles and statements of good practice. Although not legally binding, *soft law* is often used to guide behaviour and promote cooperation in areas such as international law, financial regulation and corporate responsibility.

[37] https://digital-strategy.ec.europa.eu/en/library/european-chips-act-communication-regulation-joint-undertaking-and-recommendation

[38] https://www.euronews.com/next/2024/08/20/first-european-high-performance-chips-to-be-made-in-dresden



Source CSIS

Image7 . EU share of chip production

Spain's Response: Strategic Autonomy in Action

Spain has aligned itself with this EU strategy. In May 2022, the Council of Ministers approved the Strategic Project Economic Recovery and Transformation in Microelectronics and Semiconductors (PERTE Chip)[39] . This project seeks to strengthen the design and production capabilities of the semiconductor industry in Spain, contributing to both national and European strategic autonomy.

PERTE Chip is structured around four strategic pillars that cover the entire value chain of the industry, from conception and design to chip production and the dynamization of ICT electronics manufacturing. This comprehensive approach is designed to generate a sustained demand for microchips produced in Spain and strengthen the entrepreneurial ecosystem in semiconductors, with the goal of creating a multiplier effect on the Spanish economy.

Specific actions include:

- Strengthening scientific capacity. Initiatives to boost research, development and innovation in advanced microprocessors, alternative architectures and integrated photonics. Support is also given to the development of quantum chips and a funding line is launched to consolidate the Major Project of Common European Interest (IPCEI) in

[39] https://planderecuperacion.gob.es/sites/default/files/2022-05/PERTE_Chip_memoria_24052022.pdf

Microelectronics and Communication Technologies. For this axis, an investment of €1.165 billion is foreseen between 2022 and 2027.

- Design strategy. It seeks to boost Spanish capacity in the design of microprocessors through the creation of *fabless* companies, specialised in design without the need for their own manufacturing facilities. In addition, test pilots will be implemented, and a semiconductor training network will be established. A budget of €1.33 billion has been earmarked for this objective.
- Construction of manufacturing plants. Plans include constructing plants capable of producing cutting-edge chips (below 5 nm) and mid-range chips (above 5 nm). The government has allocated €9.35 billion for this strategic axis.
- Revitalisation of the ICT industry. Creation of a capital fund specialising in chips, aimed at financing *start-ups*, *scale-ups* and innovative SMEs in the semiconductor sector in Spain, with an initial endowment of €200 million. The budget for this area amounts to 400 million euros.

Furthermore, in line with the European Law on Chips, Spain has promoted a new "Law on Industry and Strategic Autonomy", which began its legislative process with the Council of Ministers' approval of the draft bill in June 2024.[40] This initiative aims to address issues arising from external dependence on basic materials, as evidenced by the pandemic. The new legislation aims to make Spanish industry more resilient, in line with the European industrial strategy and the European Green Pact, by promoting cleaner and more sustainable industrial processes.

The commitment to reindustrialisation in Europe and Spain not only seeks to shorten supply chains and secure the supply of critical components such as semiconductors but must also be aligned with the ambitious goals of the European Green Pact. This implies a shift towards more sustainable industrial processes that promote climate neutrality and economic circularity.

In Europe, too, semiconductors have become the symbol of tensions in a globalised economy, and the European Chip Law is one of the most significant responses to this challenge. However, these measures are part of a broader overhaul of industrial policy at

[40] https://industria.gob.es/es-es/participacion_publica/Paginas/DetalleParticipacionPublica.aspx?k=680

both EU and national levels, with digital sovereignty as a cornerstone for the recovery of European industrial sovereignty.

Competition for supremacy: a critical environment for the aerospace and defence industry

Advanced semiconductors play a key role in the aerospace and defence (A&D) industry, as these chips perform highly specialised functions that require prioritising performance over other criteria common in the commercial sector, where speed to market, manufacturing simplicity and cost are often the priorities. The differences, therefore, are numerous and significant. The first difference is neither technological nor functional: the total value of the semiconductor market in A&D represents only 1-2% of the global market of around $600 billion, implying limited influence in that market.

Due to high-performance requirements, the design of these semiconductors is generally very complex. In addition, military and space specifications are much more stringent due to operational requirements, which means that design parameters such as temperature, radiation (especially in space), humidity and shock must cover wider ranges. Also, the expected lifetime of A&D chips is considerably longer than that of commercial chips.

Although A&D chip production follows the same basic steps as other chips, each step has different requirements and challenges that demand tighter control and greater resources. For example, ceramic-metal packaging is often used to increase reliability, which also adds complexity and cost. In addition, the testing of these chips requires more time and attention, as they must be certified or qualified under highly demanding standards.

Another key difference is the choice of chip substrate: while commercial chips generally use silicon, A&D chips require a variety of substrates depending on the application. In addition to silicon and silicon carbide, A&D chips often require more exotic materials for superior performance, such as gallium and its compounds (arsenide, nitride, etc.), indium and its compounds (phosphide, etc.), antimonides and others. Therefore, specialised foundries are needed, and despite the existence of many industrial foundries and large national programmes, such as the US Trusted Foundry Initiative[41] , much of the

[41] The Trusted Foundry Initiative is a US Department of Defense programme aimed at ensuring the safe and reliable supply of integrated circuits for critical defence and homeland security applications. This programme involves

production of these materials still takes place in Asia (more than 80% of the world production of gallium arsenide, for example, is today carried out in Taiwan by companies such as WIN or TMSC).

Due to the complexity of A&D chips, the supplier network is more specialised, which limits the availability of options. In addition, security is a constant concern in the A&D chip manufacturing process, as cyber threats are present at all stages of the process and require adequate countermeasures. As mentioned above, the supplier network is even more specialised than that of commercial chips, which adds a critical layer to the production process.

Another major risk for the European and Asian A&D industries is that, like many other industries whose revenues depend significantly on exports, they will be affected by the current trend in US decisions to repatriate elements of the supply chain. This trend could restrict buyers' choices and increase the proportion of US-made components in their products, which in turn would subject more of those products to US export regulatory scrutiny.

In other words, the Western A&D industry, which shares an articulated supply chain with other industries, is in an even more critical situation due to its complexity and the extreme specialisation of some of its suppliers, making it difficult to find alternatives. The gap between the US and the rest of the world remains considerable in terms of technology, capital and readiness, with the US in a much stronger position.

From another perspective, however, the A&D industry almost always enjoys a beneficial link with governments: sometimes governments have at least a partial stake in these industries and always maintain a constant level of control and attention. Western governments also fund a significant part of research and development, as the European Chip Act and the Chip and Science Act in the US have shown

In short, in a possible "chip war" scenario, the A&D sector would face a more difficult situation than other industries but would probably have the necessary government support to deal with the challenges more effectively.

collaborations with trusted foundries to produce chips that meet rigorous safety and reliability standards. The Trusted Foundry Initiative seeks to mitigate cybersecurity risks and ensure the availability of critical components for military and government operations.

Conclusions

A technological war is underway, with Washington leading the offensive. The most significant policy action so far has been the inclusion of Huawei and more than 150 of its subsidiaries on a list of sanctioned entities. This move has created a separation between US high-tech and Huawei, with the process of decoupling already advanced, if not complete. However, the results of these sanctions have not been what Washington had hoped for. Despite the pressure, Huawei has managed to maintain its position as a global leader in 5G innovation and remains a leading provider of 5G base stations.

This technology conflict threatens US-China cooperation in other crucial policy areas, as Beijing perceives the technological war as aggression aimed at impeding its progress. Moreover, the situation has exposed the limitations of US influence over its allies and third countries, many of which are opting for Huawei's more affordable 5G infrastructure. However, the Biden administration's continuation and expansion of this strategy suggests that, in the future, Washington may increasingly prioritise security interests over commercial ones in its effort to preserve US primacy on the global stage.

The tariff standoff and blacklisting of companies have left their mark on the semiconductor supply chain. In an attempt to contain China's technological advance, the United States has imposed export restrictions on advanced semiconductor manufacturing equipment, seeking to curb China's aspirations to achieve self-sufficiency in chip production. But what are the consequences of these measures? They have triggered hoarding, leading to short-term shortages and long-term overcapacity problems. Moreover, these trade barriers have led China to redouble its efforts to develop its own semiconductor production capacity, pouring billions of dollars into research and development. At the same time, US semiconductor companies, which once enjoyed unfettered access to the lucrative Chinese market, now face an uncertain future. The global supply chain, once a beacon of efficiency and interdependence, is fragmenting, calling into question the resilience and stability of the semiconductor ecosystem.

Although it is complicated, we can venture some predictions about the evolution of the "chip war" from the situation we have described, both in the short and medium term, for both semiconductor suppliers and users.

In the short term, China is likely to maintain its current subdued reaction and concentrate most of its efforts on solving its internal problems, trying, as we have noted, to regain a significant position in the semiconductor world through its own aforementioned policies.

However, when we look at the medium term, making any kind of prediction becomes risky due to the predominant influence of the political situation especially in the US.

In any case, a significant change from the current situation will come, as we have mentioned, from a trend towards de-globalisation, based on large planned public and private investments and government initiatives. This will result in a marked trend towards "inshoring", i.e. bringing back a large part of the supply chain, especially in terms of production. The impact of this movement will have to be carefully analysed because of its multiple geopolitical implications and derivations.

The battle for the chip is a modern-day game of thrones, a global chessboard where nations compete for supremacy, not with swords and shields, but with trade policies, strategic alliances and the hidden world of espionage.

The initial move in this strategic game is the manipulation of trade policies and the imposition of tariffs, manoeuvres that have significant repercussions on supply chains. And all because of the profound importance of semiconductors as the fundamental building blocks of virtually all modern technology, from smartphones to satellites. The United States and China are the main players in this global drama.

The chip/technology war transcends mere technological rivalry; it encapsulates the broader shift in global power dynamics in the 21st century. Once the domain of niche industries, semiconductors now stand as symbols of national strength: essential to defence, fundamental to economic stability and crucial to strategic autonomy. In this context, the race for supremacy reflects wider national ambitions, where securing an edge in chip technology is tantamount to securing a nation's future in a volatile global landscape.[42]

The outcomes of this ongoing contest will undoubtedly shape the geopolitical landscape for decades to come. A nation's ability - or inability - to produce and control these critical

[42] Global Trends 2040. US National Intelligence Council, pp. 54-68. https://www.dni.gov/files/ODNI/documents/assessments/GlobalTrends_2040.pdf

components will not only determine its military and economic capabilities but will also influence the very fabric of individual privacy and security.

This battle underlines the profound impact of technology on international relations and serves as a stark reminder of how far nations should go to secure their position in the global order.

The future of this global chess game, where the stakes go far beyond the semiconductor industry, is destined to define the technology hierarchy of tomorrow.

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